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(54) Title: WIPER WITH PARTICLE ATTRACTING FINISH

(57) Abstract: A textile fabric wiper is provided having a polymer coating applied to enhance the attraction of the wiper to particulate contaminants, to the surface of the wiper.

# WIPER WITH PARTICLE ATTRACTING FINISH

This invention relates to textile fabrics having a particle attracting finish applied thereto. The fabrics are referred to as wipers. The wipers find utility in cleaning a wide variety of surfaces, in both industrial and household applications.

Wipers are utilized for a number of different cleaning applications, such as in industrial cleanrooms, preparing surfaces for coatings and general cleaning. Each different application emphasizes certain standards that these types of wipers should attain. For example, wipers utilized in cleanrooms must meet stringent performance standards. These standards are related to sorbency and contamination, including maximum allowable particulate, unspecified extractable matter and individual ionic contaminants. The standards for particulate contaminant release are especially rigorous and various methods have been devised to meet them.

Wipers may be made from knitted, woven or non-woven textile fabrics. The fabric is cut into wipers, typically 9 inch by 9-inch squares. Depending on the application, wipers may remain unlaundered or may be washed in a cleanroom laundry, employing special surfactants and highly-filtered and purified water, to reduce the contamination present on the fabric. After washing, the wipers may be packaged dry, or pre-saturated with a suitable solvent before being packaged, and are ready for use.

Prior art developments in the field of wipers include reduction in particulate contaminants through the use of a specific yarn, such as "nylon bright" as disclosed in Paley et al., US 5,271,995, and reduction in loose fiber contamination by using a hot air jet to cut the fabric into pieces while simultaneously sealing the edges as disclosed in Reynolds US 5,069,735. Finishes to improve the sorbency of wipers made of hydrophilic fibers, such as polyester, have also been employed. Wiping cloths having a textile substrate and a porous polymer coating made from the "sulphonation products of cross-linked polymers containing sulphonated aromatic residues" are disclosed in

GB 2 142 225 A.

Tack cloths are textile fabrics of relatively loose weave which have been chemically treated to give them a sticky or tacky character. They are used to remove dust from surfaces prior to applying a coating and for dusting in the home. Hansen, US 3,208,093, discloses a tack cloth having a plasticizer/vinyl polymer composition applied thereto in the amount of 10 to 16 parts polymer to about 11 parts of substrate. Bennet, US 3,658,578 discloses a fabric substrate impregnated with an amorphous polypropylene compound characterized by a m.w. of less than 10,000, to achieve a tacky finish.

## Summary of the Invention

The objects of the present invention are to provide: a textile wiper with a particle attracting finish; a particle attracting wiper which will function in a wide range of applications - both dry and in conjunction with solvents; and a finish which is durable, yet exhibits little or no tack. In one embodiment, the wiper is laundered under conditions to leave a surfactant residue, which has been found to improve absorbency. In another embodiment, a textile wiper suitable for use in cleanrooms and other controlled environments where the wiper itself must be low in contaminants is provided.

Accordingly, a textile fabric having a particle attracting, polymer finish is provided for use as a wiper. The wiper may be used dry or saturated with a desirable solvent. In one embodiment, the wipe is pre-saturated with a cleaning solvent and packaged in a resealable container.

The particle attracting potential of the present wiper has been characterized by a "particle attraction coefficient" measured by the following test:

A 9" x 9" wiper is pre-wetted with water and placed in a beaker containing 250 ml of water and 250 mg (0.1% by weight) of carbon black having an average particle size of 3 microns, as measured by a Microtrac UPA-150 analyzer, and obtained from Cabot Corporation (USA), identified as carbon black M-1300. The wiper is stirred in the beaker using a magnetic

stir bar for 30 seconds and removed. Excess water in the wiper is squeezed out, draining the water back into the beaker, to give a water retention of approximately 100 weight % based on the weight of fabric. The water in the beaker is then filtered through a 1.0 micron pore size glass fiber filter. The amount of carbon black particulate which was left in the beaker is calculated, and the amount of carbon black particulate absorbed by the wiper can be determined. The test is repeated for the identical fabric, without the particle attracting finish having been applied. The particle attraction coefficient (%) is calculated using the following formula:

$$\frac{\text{wt. of particulate (fabric + finish) - wt. of particulate (fabric only)}}{\text{wt. of particulate (fabric only)}} \times 100$$

For example, the wiper having the finish of the present invention absorbed 33 mg of carbon black, while the fabric without the finish absorbed only 13 mg. The particle attraction coefficient is 154%.

The particle attracting polymer may be selected from compounds having pendent groups which (i) exhibit hydrogen bonding, such as hydroxy, hydroxyalkyl and carboxy groups; (ii) have acid-base reactive groups, such as -COOH, $-NH_2$, $-SO_3$, and $-NO_3$. In one embodiment of the invention, the particle attracting polymer is water-soluble and selected from (i) polysaccharides having a plurality of pendent groups selected from hydroxy, hydroxyalkyl and carboxy groups; and (ii) polymers formed by vinyl

polymerization, having a plurality of pendent groups selected from hydroxy, hydroxyalkyl, carboxy, amino and alkylamino groups.

The invention further incorporates one or more of the following features:

- The wiper has a finished edge
- The wiper is made from a fabric having a loop pile, cut pile or waffle knit construction
- The wiper is made from fabric constructed of microdenier fiber
- The wiper is an unslit, double-needle bar knit sandwich fabric
- The wiper is attached to a sponge or foam
- The wiper is made from "splittable" fibers, which split lengthwise into multiple microdenier fibers
- The wiper has a thickness of 20 mils or greater
- The wiper has an absorbtivity for water (intrinsic sorbency) of 2 ml per gram of fabric or greater.

The advantage of the wiper relative to uncoated wipers, include greater pick up of particulate matter during dry or wet cleaning. It is believed that the combination of the particle attracting finish and a wiper constructed of microdenier fibers is particularly beneficial in providing a large surface area of treated fiber, thereby optimizing the likelihood that a particle will be adsorb onto the wiper during cleaning.

A further advantage of the wipers of the present invention is that the particle attracting polymer is believed to reduce particle release from the wiper, such as low molecular weight polyester, which migrates to the surface of polyester fiber. Without being bound to a particular theory, it is believed that the particle attracting polymer may form a thin, non-tacky adhesive layer that adheres the particles to the fibers and prevents the particulate contaminants from being released by the wiper.

**Detailed Description of the Invention**

Without limiting the scope of the invention, the preferred embodiments and features are hereinafter set forth. Unless otherwise indicated, the following conditions apply: all parts and percentages are by weight; conditions are ambient, i.e. one atmosphere of pressure and 25° C; the term "average" means number-average; aliphatic hydrocarbons, including alkyl and alkylene radicals, comprise from 1 to 4 carbon atoms. Unless otherwise indicated, the particle attraction coefficient is measured using particles having an average size of approximately 3 microns, as measured by laser light scattering.

All of the United States patents cited in the Specification are incorporated by reference.

The wipers of the present invention are textile fabrics having a particle attracting finish and are shaped for convenient use in cleaning surfaces. The wiper may be hand-held, such as a dust cloth, dish rag or mitt.

Alternatively, the wiper may be designed as a mop head or a covering for a resilient substrate, such as a sponge. Wipers may be provided in a wide variety of sizes and shapes. For example, wipers may vary in size from 4 square inches to 1,300 square inches. Typically, wipers are from 10 square inches to 600. The most common form of wipers is a rectangle, but any geometry may be employed.

The wiper is preferably provided with a finished edge, which refers to a treatment to prevent the edge of the fabric from unraveling, running or from generating lint. Examples of suitable techniques include fusing, such as with heat, e.g. hot knife, radiant heat, hot air, ultrasonic energy or laser, serging and hemming. Reynolds, U.S. Patent No. 5,069,735 discloses techniques for fusing the edges of a wiper.

The wipers of the present invention may be constructed from woven, knitted or non-woven fabric. Non-woven fabrics and their methods of manufacture are well known in the art. For example, non-woven fabrics may be wet laid, dry laid, spun bond, needle punched; with or without binders to stabilize them. Preferably, the fabric construction is designed to increase the adsorption of particles and adsorption of cleaning solvents, when the wiper is used to clean a surface, by increasing the surface area of exposed fibers on the face of the fabric, relative to a "flat" fabric construction, such as a plain weave. Examples useful fabric constructions include loop pile, cut pile, waffle knit, napped and corduroy fabrics. Preferably, the wipers have a

thickness of 20 mils or greater, more preferably, 30 mils or greater, as measured by ASTM D1777-96.

The fabric may be made from staple or continuous filament fibers, or yarns made from such fibers. Yarns having a wide variety of denier and filament count may be employed. By way of example, yarns having a denier to filament ratio of from 0.1 to 10, a denier of 15 to 250 with filament counts ranging from 10 to 250 may be employed. Preferably, the fabric is constructed of microdenier fibers, that is, fibers having less than one denier per filament. In one alternative, a splittable fiber is employed in the construction of the fabric. Splittable fibers are synthetic fibers, typically manufactured from two different polymers, such as polyester/polyamide, which split lengthwise to create a bundle of smaller fibers. The different polymers may be arranged in layers or in "wedges", such that the cross-section of the fiber resembles a sliced pie. For example, a splittable fiber having a denier greater than one, may split to form several microdenier filaments. Fibers that split in ratios of from 1:3 to 1:20 are particularly useful. The manufacture of splittable fibers is known and such fibers are commercially available.

The fiber may be selected from synthetic and natural fibers and blends thereof. For example, the fiber may be polyester, polyamide, polyolefin e.g. polyethylene, polypropylene and ethylene/propylene copolymer, acrylic, polyurethane, cellulosic, e.g. cotton, polylactic acid,

rayon and acetate, silk or wool, and blends thereof. Preferably, the fiber is polyester, polyamide or polyolefin, most preferably in the form of a continuous filament yarn.

In one embodiment of the invention, the wiper is a loop pile, circular, double knit fabric. The loops are made with a splittable polyester/nylon yarn. During processing or use of the fabric, such as scouring in hot water, the splittable yarns "delaminate" to create loops made of a plurality of microdenier fibers.

A wide range of fabric weights may be employed in the present invention. Typically, the fabrics used for cleanroom wipers have a weight of 1 to 16 ounces per square yard, preferably 2 to 9 ounces per square yard.

The fabric may be washed or scoured to remove spinning oils, dirt and other contamination prior to application of the particle attracting polymer. It is usually advantageous to heat set the fabric, either before or after application of the polymer, to provide dimensional stability. The fabric is preferably heat set at a temperature above what the yarns have previously experienced, after the initial spinning of the fiber. For example, polyester yarn may be heat set at a temperature of from 180° to 400° F. Preferably, the fabric lies flat when it is heat set.

Heat setting may advantageously be performed in a tenter frame oven, in which the fabric is held flat during heating and while it begins to cool. The temperature of the oven may be higher than the temperature actually

experienced by the yarn, which will be a function of the oven or dryer temperature profile, length and speed of the fabric through the oven.

The particle attracting polymer finish or coating may be applied by any suitable method used to apply a coating in the form of a solution, dispersion, emulsion or a particulate to a fabric substrate. By way of example, the polymer may be applied by padding, wash wheel, foaming, spraying, nip roll, knife blade or in a jet dyeing apparatus. Preferably, the polymer is in the form of an aqueous solution.

The coat weight (solids) may be 0.01 wt.% or greater based on the weight of the fabric. Typically the coat weight is not greater than 25 wt.%. Preferably, the coat weight is from 0.02 to 10 wt.%, most preferably from 0.05 to 3 wt.%, based on the weight of the fabric. The particle attracting polymer is cured by a method appropriate to the polymer and the form in which it is applied (liquid or solid), and any residual liquor is evaporated. For example, if the polymer is applied in the form of a solution, dispersion or emulsion, the coated fabric may be dried and cured in a tenter oven.

The particle attracting polymer may be selected from polymers which exhibit an affinity for one or more of the following types of particulate matter: carbon black, aluminum, aluminum oxide, copper, copper oxide, ferrite, graphite, iron, iron oxide, manganese, manganese oxide, silicon, silicon dioxide, titanium, titanium dioxide, tungsten, tungsten dioxide, zinc and zinc oxide, preferably an affinity for one or more of the following types

of particulate matter: carbon black, copper, copper oxide, silicon, silicon dioxide, tungsten and tungsten dioxide. Of particular concern are such particles in the range of 0.5 to 20 microns.

The efficacy of a particular wiper in attracting and removing particulate contaminants, from a surface or liquor, is referred to herein as a "particle attraction coefficient." The test has been previously described. Briefly, the particle attraction coefficient is the ratio of the increased particle attracting characteristics of a polymer coated wiper, relative to an uncoated wiper, for a given particle type. Preferably, the coated wiper of the present invention has a particle attraction coefficient for 1-5 micron size particles of 50% or greater, most preferably, 100% or greater.

In addition to the aforementioned particulate matter, the wiper of the present invention is useful in removing a variety of inorganic and organic matter from surfaces. By way of example and not limitation, the wiper may be used to clean the following substances from a surface: lint, dirt, soap scum, food, tarnish, oxidation, grease, oil and precipitates. The aforementioned particles may range in size from 0.5 microns to 1,000 microns.

Examples of particle attracting polymers include the following:

(i) cellulose ethers, e.g. hydroxyalkylcelluloses, such as hydroxyethylcellulose and hydroxypropylcellulose; hydroxyalkylalkylcelluloses, such as hydroxyethylethylcellulose,

hydroxybutylmethylcellulose, hydroxypropylmethylcellulose and hydroxyethylmethylcellulose; alkylcelluloses, such as methylcellulose and ethylcellulose; carboxyalkylcelluloses, such as sodium carboxymethylcellulose;

(ii) inorganic cellulose esters, e.g. cellulose nitrate;

(iii) chitosan; and

(iv) guar gums and hydroxy, hydroxyalkyl and carboxy substituted derivatives thereof; e.g. carboxymethylguar gum, carboxymethyl(hydroxypropyl)guar gum, hydroxyethylguar gum and hydroxypropylguar gum.

(v) starch and hydroxy, hydroxyalkyl and carboxy substituted derivatives thereof; e.g. hydroxyethylstarch and hydroxypropylstarch;

(vi) poly(vinyl alcohol) and vinyl alcohol copolymers, e.g. ethylene/vinyl alcohol copolymers and vinyl alcohol/methacrylate or methylmethacrylate copolymers;

(vii) poly(vinyl pyrrolidone);

(viii) poly(hydroxyalkyl acrylate) and poly(hydroxyalkyl methacrylate), e.g. poly(hydroxypropyl methacrylate), poly(hydroxypropyl acrylate); and

(ix) poly(alkyl acrylamide) and poly(alkyl acrylamide) copolymers, e.g. poly(isopropyl acrylamide) and isopropyl acrylamide/acrylic acid copolymer.

The class of suitable particle attracting polymers includes compounds having a broad range of molecular weights and solubilities in water. By way of example, polymers having an average molecular weight of from 1,000 to 2,000,000, preferably 25,000 to 1,000,000, most preferably 50,000 to 500,000 may be employed. Preferably, the polymer is water soluble, defined as a solubility of one part per 100 parts of water or greater, before the polymer is applied to the fabric and cured. Nevertheless, it is also desirable that the polymer, once applied to the fabric and cured, has sufficient durability to withstand laundering, such as in a cleanroom laundry. The particle attracting polymer may also be applied to the fabric with a binder, or cross-linker, preferably in minor amounts, such as melamine formaldehyde resin binder.

It is believed that in most cases, the polymer forms a film on the fibers of the textile fabric. The objects of the invention may be achieved, however, whether the polymer forms a continuous film or is discontinuous.

In addition to the particle attracting polymer, other finishes may be applied to the textile fabric. For example, the textile fabric may be treated with a "soil release" finish to improve its wettability and washability, such as may be found in the following U.S. patents: Marco, US 4,131,550; Hauser, US 4,164,392; Marco, US 4,168,954; Marco, US 4,170,557; Marco, US 4,235,735; Kimbrell, US 4,329,389; Schuette, US 5,725,951. Examples of other compounds and compositions which may be applied to the textile

fabric or used in conjunction with the particle attracting polymer include: plasticizers, antistatic agents, defoamers, anti-microbial or anti-fungal agents, lubricants, knitting oils and abrasives.

In one embodiment, a surfactant residue is left on the wiper from the laundering process, and has been found to improve absorbency. The surfactant or surface-active agent may be selected from cationic, anionic, nonionic and ampholytic surfactants. A comprehensive description of surfactants finding utility herein may be found in the Kirk-Othmer Encyclopedia of Chemical Technology, 4th edition, pp. 478-541 (1997). Preferably, the surfactant is selected from anionic and nonionic surfactants.

A surfactant residue in the range of 0.00001 wt.% (0.1 ppm) to 0.5 wt.%, preferably 0.00005 wt.% (0.5 ppm) to 0.1 wt.%, has been found to significantly improve the absorbance of the wiper, especially with regard to polar solvents, such as alcohols and water. High levels of residue on the wiper may act as a source of contamination and are to be avoided.

The wipers may be presaturated with a desired solvent and sold in sealed dispensers, as is well known in the art. The terms saturated and presaturated are used in their broad sense, i.e. wet with solvent. Suitable solvents include water, organic solvents such as naphtha, and aqueous solutions of water miscible organic solvents, in particular solutions of alcohols, such as $C_1$-$C_8$ alcohols. Of particular interest are wipers presaturated with a solution of isopropanol and water, for example, aqueous

solutions containing 1 to 99 wt.% isopropanol. The solvent composition may also contain a surfactant and/or other additives selected for their cleaning characteristics. By way of example, additional solvents and packages for pre-saturated wipers may be found in the following references: US 3,994,751; US 4,627,936; US 4,639, 327; US 4,998,984; US 5,145,091; US 5,344,007 and JP 6[1994]-48475. Alternatively, the wipers may be sealed in air tight packages while dry.

If the wiper is intended for use in a cleanroom environment, it is desirable to wash the fabric or wipers in a cleanroom laundry, which may be characterized as a laundry facility to remove and minimize contamination of the wipers, prior to packaging. The cleanroom laundry may employ special filters, surfactants, sequestrants, purified water, etc. to remove oils, reduce particle count and extract undesirable ion contaminates. The laundering process should not be overly aggressive, as the particle attracting finish may be removed. Depending on the equipment employed, it may be necessary to adjust the agitation, volume and duration of rinsing and the speed and duration of extraction. Examples of suitable equipment and description of cleanroom laundries may be found in Austin, Dr. Philip R., "Encyclopedia of Cleanrooms, Bio-Cleanrooms and Aseptic Areas", Contamination Control Seminars, Michigan (1995).

Standards for Cleanroom Wipers

Among the standards which may be imposed on cleanroom wipers include performance criteria related to sorbency and contaminates. One standard for evaluating cleanroom wipers is the Institute of Environmental Sciences & Technology (IEST), Contamination Control Division Recommended Practice 004.2, which may be cited as IEST-RP-CC004.2, "Evaluating Wiping Materials Used in Cleanrooms and Other Controlled Environments".

Section 7 of Recommended Practice 004.2 sets forth some of the tests utilized for determining the capacity and rate sorption of cleanroom wipers. The test is also used herein for wipers not intended for cleanroom use. The capacity test is performed by saturating a known area of wiper with a selected liquid (water in this case) and then calculating the volume sorbed per unit mass and per unit area of wiper (IEST-RP-CC004.2 § 7.1). The sorbency per unit mass is referred to as the "intrinsic sorbency" and is the volume of liquid in milliliters sorbed per unit of mass of wiper in grams. The "extrinsic sorbency" is the volume of liquid in milliliters sorbed per unit area of wiper in square meters.

The rate of sorption of a cleanroom wiper is measured by allowing a drop of water to fall from a fixed height onto the surface of a wiper. The time required for the disappearance of specular reflection from the drop is measured and recorded as the sorption rate (IEST-RP-CC004.2 § 7.2).

The primary test for contamination associated with cleanroom wipers are those measuring particles, unspecified extractable matter, and individual ionic constituents. The number of particles released during wetting and mechanical stress can be measured in the Biaxial Shake Test (IEST-RP-CC004.2 § 5.2). Briefly, the wipers are placed in a jar of water and shaken. Aliquots are removed from the shaker and the number of particles is counted, typically those in the size range of 0.1 microns and larger are specified. The number of particles greater than a given particle size are reported in millions per square meter of fabric.

The amount of extractable contamination associated with a cleanroom wiper is determined by extracting the wiper with a solvent, such as water, isopropyl alcohol or acetone, evaporating the solvent and weighing the non-volatile residue (IEST-RP-CC004.2 § 6.1). The quantity of extracted matter may be reported as mass extracted per mass of wiper or mass extracted per unit area of wiper.

The organic and inorganic non-volatile residue may be further analyzed, when it is desirable to know how much of a particular species is present. Typically, the non-volatile residue is tested for various inorganic, anionic or cationic constituents, for example Al, Ca, Cl, F, Li, Mg, K, Na and Zn (IEST-RP-CC004.2 §6.2).

By following the teachings of the present invention, it is possible to manufacture wipers which not only have superior cleaning characteristics,

but also meet the requirements for Class 1, Class 10, Class 100, Class 1,000, Class 10,000 and Class 100,000 cleanrooms as defined in Federal Standard 209 E. In particular, the wipers meet one or more of the following objectives: to reduce particulate contamination of particles greater than 0.5 microns to a level of less than 75 million/meters$^2$, preferably less than 30 million/meters$^2$, as measured by the Biaxial Shake Test (IEST-RP-CC004.2 §5.2); to reduce particle contamination of particles greater than 5 microns to a level of less than 1 million/m$^2$, preferably less than 300,000/m$^2$, most preferably less than 150,000/m$^2$, as measured by the Biaxial Shake Test (IEST-RP-CC004.2 §5.2); to reduce non-volatile residues with water extraction to less than .005 grams/meters$^2$, and even less than .003 grams/meters$^2$ as measured by short term extraction (IEST-RP-CC004.2 §6.1.2); and to achieve absorbance capacities of 3.5 milliliters/meters$^2$ or greater, and even 4.0 milliliters/meters$^2$ or greater (IEST-RP-CC004.2 §7.1).

The invention may be further understood by reference to the following examples.

Example 1 (Comparative)

Yarn A, a 150 denier, 48 filament yarn of continuous, splittable (multi-layer) nylon/polyester, co-extruded fibers, which split into 11 filaments each, and Yarn B, a 150 denier, 34 filament polyester yarn, were knit in a double-knit, waffle construction, containing ridges which exposed the splittable yarn, primarily on the surface of the ridges. The fabric was

then scoured in hot water (90° C) causing the splittable yarn to "delaminate", creating microdenier fibers. The fabric was then dyed in a standard jet dyeing apparatus.

The fabric had a thickness of 33.6 mils, a weight of 5.4 ounces per square yard, an intrinsic absorption of 2.4 milliliters per gram and an extrinsic absorption of 435.5 milliliters per square meter.

Example 2 (PVA Finish)

A waffle knit fabric was prepared according to Example 1, except that 0.5 wt. % of PVA (DuPont Elvanol 7130), 100% hydrolyzed polymer was included in the final rinse of the jet dyeing step. The pickup of PVA was 0.5 wt. % based on the weight of the fabric.

The fabric had a thickness of 48.0 mils, a weight of 6.9 ounces per square yard, an intrinsic absorption of 2.8 milliliters per gram and an extrinsic absorption of 648 milliliters per square meter.

Example 3 (Comparative)

A waffle knit fabric was prepared according to Example 1, except that the splittable microdenier Yarn A was replaced with a 2-ply, textured 70 denier, 100 filament polyester continuous filament yarn.

The fabric had a thickness of 38.1 mils, a weight of 6.0 ounces per square yard, an intrinsic absorption of 2.3 milliliters per gram and an extrinsic absorption of 458.8 milliliters per square meter.

Example 4 (PVA Finish)

A waffle knit fabric was prepared according to Example 3, except that 0.5 wt. % PVA (DuPont Elvanol 7130) was included in the final rinse of the jet dyeing step. The pick up of PVA was 0.5 wt. % based on the weight of the fabric.

The fabric had a thickness of 41.4 mils, a weight of 6.4 ounces per square yard, an intrinsic absorption of 2.5 milliliters per gram and an extrinsic absorption of 539.0 milliliters per square meter.

Example 5

The fabrics of Examples 1-4 were cut into 9" x 9" wipers and tested for their particle attraction coefficient using carbon black (3 microns) according to the procedure outlined herein. The results were compared to the corresponding pairs of untreated and treated wipers and are reported in Table 1 below.

Table 1

| Example | Carbon Black Pickup Weight | Particle Attraction Coefficient |
|---|---|---|
| 1 (Comparative) | 0.0712g | --- |
| 2 (PVA Finish) | 0.1526g | 114% |
| 3 (Comparative) | 0.1291g | --- |
| 4 (PVA Finish) | 0.2046g | 58% |

The foregoing examples demonstrate the efficacy of the wiper having a particle attracting finish in absorbing and retaining particulates, especially those in the target range of 0.5 to 20 microns. The wipers attract particulate

in both a wet and dry environment, especially in an aqueous environment, such as might be encountered when using a wiper saturated with a solvent. The wipers are not tacky, and the polymer coating does not leave a residue when the wiper is used to clean a surface, wet or dry.

The wipers find utility in cleaning surfaces in virtually any industrial or general cleaning application. By way of example, the wiper may be used to clean the following surfaces: metal, ceramic, porcelain, glass, wood, thermoplastic, thermoset and elastomeric polymers. The wiper may also be used for personal hygiene, especially cleaning the skin. The wiper may be used dry or wetted with an appropriate cleaning solution. In addition to water and the organic solvents and surfactants previously mentioned herein, the cleaning solution may comprise ammonia and ketones. The wipers may be hand-held, attached to a handle or other support, such as a mop, or used to cover a resilient substrate, such as sponge. The wipers may also be useful in cleanroom environments, such as in semiconductor, optical, food packaging and pharmaceutical cleanrooms.

There are, of course, many alternate embodiments and modifications of the invention, which are intended to be included within the scope of the following claims.

What we claim is:

1. A wiper comprising a textile fabric and a particle attracting polymer coated on the fabric at a level of at least 0.01 weight % based on the weight of the fabric, wherein the polymer is selected from the group consisting of compounds that have (a) pendent groups that exhibit hydrogen bonding; and (b) pendant acid-base reactive groups, and the polymer has an average molecular weight of 1,000 to 2,000,000.

2. The wiper of Claim 1 wherein the fabric is at least 20 mils thick, the polymer is selected from the group consisting of (i)polysaccharides having a plurality of pendent hydroxy, hydroxyalkyl and carboxy groups; and (ii) polymers formed by vinyl polymerization, having a plurality of pendent groups selected from hydroxy, hydroxyalkyl, carboxy, amino and alkylamino groups, the polymer having an average molecular weight of from 25,000 to 1,000,000.

3. The wiper of Claim 2 wherein the wiper has a fused or serged edge, and a particle attraction coefficient of 50% or greater for one or more of the types of particles selected from the group consisting of carbon black, copper, copper oxide, silicon, silicon oxide, tungsten and tungsten oxide particles.

4. The wiper of Claim 3 wherein the fabric comprises microdenier fibers.

5. The wiper of Claim 1 wherein the fabric is selected from the group consisting of loop pile, cut pile and waffle knit fabrics.

6. The wiper of Claim 5 wherein the fabric has a fused or serged edge, the polymer is selected from the group consisting of (i)polysaccharides having a plurality of pendent hydroxy, hydroxyalkyl and carboxy groups; and (ii) polymers formed by vinyl polymerization, having a plurality of pendent groups selected from hydroxy, hydroxyalkyl, carboxy, amino and alkylamino groups, and the polymer is coated on the fabric at a level of 0.05 to 3 weight % based on the weight of the fabric.

7. The wiper of Claim 5 wherein the fabric comprises microdenier fibers derived from splittable fibers incorporated into the fabric.

8. The wiper of Claim 1 wherein the polymer is selected from the group consisting of (i)polysaccharides having a plurality of pendent hydroxy, hydroxyalkyl and carboxy groups; and (ii) polymers formed by vinyl polymerization, having a plurality of pendent groups selected from hydroxy, hydroxyalkyl, carboxy, amino and alkylamino groups, and the fabric comprises microdenier fibers incorporated into the fabric.

9. The wiper of Claim 1 wherein the wiper is from 10 to 600 square inches in size and has a finished edge.

10. The wiper of Claim 9 having a particle attraction coefficient of 50 % or greater for carbon black.

11. A wiper comprising a textile fabric and a particle attracting polymer coated on the fabric at a level of at least 0.01 weight % based on the weight of the fabric, wherein the polymer is selected from the group consisting (i) cellulose ethers; (ii) inorganic cellulose esters; (iii) chitosan; (iv) guar gums and hydroxy, hydroxyalkyl and carboxy substituted derivatives thereof; (v) starch and hydroxy, hydroxyalkyl and carboxy substituted derivatives thereof; (vi) poly(vinyl alcohol) and vinyl alcohol copolymers; (vii) poly(vinyl pyrrolidone); (viii) poly(hydroxyalkyl acrylate) and poly(hydroxyalkyl methacrylate) and (ix) poly(alkyl acrylamide) and poly(alkyl acrylamide) copolymers.

12. The wiper of Claim 11 wherein the fabric is at least 30 mils thick, and the polymer is coated on the fabric at a level of 0.05 to 3 weight % based on the weight of the fabric.

13. The wiper of Claim 12 wherein the fabric comprises microdenier fibers.

14. The wiper of Claim 12 wherein the polymer is selected from the group consisting of cellulose ethers, poly(vinyl alcohol) and vinyl alcohol copolymers, has a molecular weight of from 25,000 to 1,000,000.

15. The wiper of Claim 11 wherein the fabric is selected from the group consisting of loop pile, cut pile and waffle knit fabrics, and the polymer has an average molecular weight of 1,000 to 2,000,000.

16. The wiper of Claim 15 wherein the polymer is selected from the group consisting of cellulose ethers, poly(vinyl alcohol) and is coated on the fabric at a level of 0.5 to 3 weight % based on the weight of the fabric.

17. The wiper of Claim 15 wherein the fabric comprises microdenier fibers, and the wiper has a particle attraction coefficient of 50 % or greater for carbon black.

18. The wiper of Claim 11 having a particle attraction coefficient of 50% or greater for one or more of the types of particles selected from the group consisting of carbon black, copper, copper oxide, silicon, silicon oxide, tungsten and tungsten oxide particles.

19. The wiper of Claim 11 wherein the wiper is from 10 to 600 square inches in size and has a fused or serged edge.

20. The wiper of Claim 11 wherein the fabric a loop pile fabric and comprises microdenier fibers, the wiper is from 10 to 600 square inches in size and has a particle attraction coefficient of 50 % or greater for carbon black, and the polymer has an average molecular weight of from 25,000 to 1,000,000 and is coated on the fabric at a level of 0.05 to 3 weight % based on the weight of the fabric.

21. A method of cleaning a surface to remove particles comprising the steps of wiping the surface with the wiper of Claim 1.

22. The method of Claim 21 wherein the surface is wiped with the wiper of Claim 2.

23. The method of Claim 21 wherein the surface is wiped with the wiper of Claim 5.

24. The method of Claim 21 wherein the surface is wiped with the wiper of Claim 10.

25. The method of Claim 21 wherein the surface is selected from the group consisting of metal, ceramic, porcelain, glass, wood, thermoplastic, thermoset and elastomeric polymers.

26. The method of Claim 21 wherein the wiper is wetted with a composition selected from the group consisting of water miscible organic solvents, aqueous solutions of water miscible organic solvents, and aqueous surfactant solutions.

27. A method of cleaning a surface to remove particles comprising the steps of wiping the surface with the wiper of Claim 11.

28. The method of Claim 27 wherein the surface is wiped with the wiper of Claim 12.

29. The method of Claim 27 wherein the surface is wiped with the wiper of Claim 15.

30. The method of Claim 27 wherein the surface is wiped with the wiper of Claim 20.

31. The method of Claim 27 wherein the surface is selected from the group consisting of metal, ceramic, porcelain, glass, wood, thermoplastic, thermoset and elastomeric polymers.

32. The method of Claim 31 wherein the wiper is wetted with a composition selected from the group consisting of water miscible organic solvents, aqueous solutions of water miscible organic solvents, and aqueous surfactant solutions.

# INTERNATIONAL SEARCH REPORT

In nal Application No
PCT/US 01/06588

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 A47L13/16 D06M15/09 D06M15/07 D06M15/03 D06M15/05
D06M15/11 D06M15/333 D06M15/356 D06M15/263 D06M15/285

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 D06M A47L

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

° Special categories of cited documents :

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| Date of the actual completion of the international search | Date of mailing of the international search report |
|---|---|
| 11 September 2001 | 19/09/2001 |

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| European Patent Office, P.B. 5818 Patentlaan 2<br>NL - 2280 HV Rijswijk<br>Tel. (+31-70) 340-2040, Tx. 31 651 epo nl,<br>Fax: (+31-70) 340-3016 | Pamies Olle, S |

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Int al Application No
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